

1    Claims

2

3    1. A material which shatters, when broken, into  
4    fragments which do not cut, puncture or otherwise  
5    damage human skin or tissue, wherein the material is  
6    comprised of an amorphous thermoplastic polymer and  
7    one or more low molecular weight resins.

8

9    2. A material as claimed in Claim 1 comprised of a  
10   simple mixture of amorphous thermoplastic polymer  
11   and one or more low molecular resins.

12

13   3. A material as claimed in any one of the proceeding  
14   Claims wherein the amorphous thermoplastic polymer  
15   is selected from the group consisting of polystyrene  
16   (PS), polymethyl methacrylate (PMMA), styrene-  
17   acrylonitrile copolymer (SAN), linear polyesters and  
18   co-polyesters and polycarbonate (PC).

19

20   4. A material as claimed in any one of the proceeding  
21   claims having a tensile stress limit between 11 and  
22   60 Nmm<sup>-2</sup>.

23

24   5. A material as claimed in any one of the proceeding  
25   claims wherein the low molecular weight resin has an  
26   Mn (number average molecular weight) such that it  
27   has less than 500 repeating units.

28

29   6. A material as claimed in Claim 5 wherein the low  
30   molecular weight resin has an Mn (number average  
31   molecular weight) such that it has less than 50  
32   repeating units.

33

1       7. A material as claimed in any one of the proceeding  
2       claims manufactured in sheet form.

3

4       8. A polymeric blend comprising a polymer selected from  
5       the group consisting of: polystyrene (PS),  
6       polymethyl methacrylate (PMMA), styrene-  
7       acrylonitrile copolymer (SAN), linear polyesters and  
8       co-polyesters and polycarbonate (PC) and one or more  
9       low molecular weight resins.

10

11       9. A polymeric blend as claimed in Claim 8 wherein the  
12       one or more low molecular weight resins have an Mn  
13       (number average molecular weight) such that it has  
14       less than 500 repeating units.

15

16       10. A polymeric blend as claimed in Claim 9 when in  
17       the one or more low molecular weight resins have an  
18       Mn (number average molecular weight) such that it  
19       has less than 50 repeating units.

20

21       11. A polymeric blend as claimed in any one of Claims  
22       8 to 10 wherein the one or more molecular weight  
23       resins are hydrocarbon resins.

24

25       12. A polymeric blend as claimed in Claim 11 wherein  
26       the hydrocarbon resins are aromatic hydrocarbon  
27       resins.

28

29       13. A polymeric blend as claimed in any one of Claims  
30       8 to 12 manufactured in sheet form.

31

32       14. A material which shatters, when broken, into  
33       fragments which do not cut, puncture or damage human  
34       skin or tissue, the material being comprised of

1       polystyrene and one or more low molecular weight  
2       resins.

3

4       15. A material as claimed in Claim 14 comprised of a  
5       simple mixture of polystyrene and one or more low  
6       molecular weight resins.

7

8       16. A material as claimed in any one of Claims 14 to  
9       15 wherein the one or more low molecular weight  
10      resins are hydrocarbon resins.

11

12      17. A material as claimed Claim 16 wherein the  
13      hydrocarbon resins are aromatic hydrocarbon  
14      resins.

15

16      18. A material as claimed in Claim 17 wherein the  
17      aromatic hydrocarbon resins are C9 aromatic  
18      hydrocarbon resins.

19

20      19. A material as claimed in any one Claims 14 to 18  
21      wherein the one or more low molecular weight  
22      resins are, or are derived from, alpha methyl  
23      styrene.

24

25      20. A material as claimed in any one of Claims 14 to  
26      19 wherein the one or more low molecular weight  
27      hydrocarbon resins are selected from a group  
28      consisting of; Norsolene™, Kristalex™, Plastolyn™,  
29      Endex™, Piccotex™, Piccolastic™, Sukorez™ or  
30      Arkon™.

31

32      21. A material as claimed in Claim 20 wherein the one  
33      or more low molecular weight hydrocarbon resins  
34      are selected from a group consisting of;

1           Norsolene W90™, Norsolene W100™, Norsolene W110™,  
2           Kristalex F85™, Kristalex F100™, Kristalex F115™,  
3           Plastolyn 240™, Plastolyn 290™, Endex155™,  
4           Piccolastic D125™, Sukorez 100™, Sukorez 120™,  
5           Arkon P100™, Arkon P125™, Arkon P140™, Piccotex  
6           75™, Piccotex 100™ or Piccotex 120™.

7

8       22. A material as claimed in any one of Claims 14 to  
9           21 wherein the one or more low molecular weight  
10          resins have an Mn (number average molecular  
11          weight) such that it has less than 500 repeating  
12          units.

13

14      23. A material as claimed in Claim 22 wherein the one  
15          or more low molecular weight resins have an Mn  
16          (number average molecular weight) such that it has  
17          less than 50 repeating units

18

19      24. A material as claimed in any one of Claims 14 to  
20          23 having a tensile stress limit between 11 and 60  
21          Nmm<sup>-2</sup>.

22

23      25. A material as claimed in any one of Claims 14 to  
24          24 which also includes one or more additives  
25          selected from the group including UV inhibitors,  
26          antioxidants, flow modifiers, fire retarding  
27          agents, colour pigments and brighteners, and  
28          oxygen scavengers.

29

30      26. A material as claimed in any one of Claims 14 to  
31          25 manufactured in sheet form.

32

33      27. A method of manufacturing a material which  
34          shatters, when broken, into fragments which do not

1           cut, puncture or damage human skin or tissue, the  
2           method comprising the step of mixing an amorphous  
3           thermoplastic polymer and one or more low  
4           molecular weight resins.

5

6       28. A material as claimed in Claim 27 wherein the  
7           amorphous thermoplastic polymer is chosen from the  
8           group consisting of polystyrene (PS),  
9           Polymethyl methacrylate (PMMA), styrene-  
10          acrylonitrile copolymer (SAN), linear polyesters  
11          and co-polyesters polycarbonate (PC).

12

13       29. A material as claimed in any one of Claims 27 to  
14           28 wherein the one or more low molecular weight  
15           resins are hydrocarbon resins.

16

17       30. A material as claimed in Claim 29 wherein the  
18           hydrocarbon resins are aromatic hydrocarbon  
19           resins.

20

21       31. A material as claimed in any one of Claims 27 to  
22           30 wherein the low molecular weight resin has an  
23           Mn (number average molecular weight) such that it  
24           has less than 500 repeating units.

25

26       32. A material as claimed in Claim 31 wherein the low  
27           molecular weight resin has an Mn (number average  
28           molecular weight) such that it has less than 50  
29           repeating units.

30

31       33. A material as claimed in any one Claims 27 to 37  
32           wherein the glass transition temperature (Tg) of  
33           the material is elevated as the amorphous

- 1           thermoplastic polymer is mixed with the one or  
2           more low molecular weight hydrocarbon resins.
- 3
- 4       34. A material as claimed in Claim 33 when the T<sub>g</sub> is  
5           elevated to 5-10°C higher than the base polymer.
- 6
- 7       35. A method of manufacturing a material which  
8           shatters, when broken, into fragments which do not  
9           cut, puncture or damage human skin or tissue, the  
10          methods comprising the step of mixing polystyrene  
11          and one or more low molecular weight hydrocarbon  
12          resins.
- 13
- 14       36. A method as claimed in Claim 35 wherein the one or  
15          more low molecular weight resins are hydrocarbon  
16          resins.
- 17
- 18       37. A method as claimed in Claim 36 wherein the  
19          hydrocarbon resins are aromatic hydrocarbon  
20          resins.
- 21
- 22       38. A method as claimed in Claim 36 wherein the  
23          aromatic hydrocarbon resins are C9 aromatic  
24          hydrocarbon resins.
- 25
- 26       39. A method as claimed in any one of Claims 35 to 38  
27          wherein the one or more low molecular weight  
28          resins are, or are derived from, alpha methyl  
29          styrene.
- 30
- 31       40. A method as claimed in any one of Claims 35 to 39  
32          wherein the one or more low molecular weight  
33          hydrocarbon resins are selected from a group  
34          consisting of; Norsolene™, Kristalex™, Plastolyn™,

1           Endex™, Piccotex™, Piccolastic™, Sukorez™ or  
2           Arkon™.  
3

4        41. A method as claimed in Claim 40 wherein the one or  
5           more low molecular weight hydrocarbon resins are  
6           selected from a group consisting of Norsolene  
7           W90™, Norsolene W100™, Norsolene W110™, Kristalex  
8           F85™, Kristalex F100™, Kristalex F115™, Plastolyn  
9           240™, Plastolyn 290™, Endex155™, Piccolastic  
10          D125™, Sukorez 100™, Sukorez 120™, Arkon P100™,  
11          Arkon P125™, Arkon P140™, Piccotex 75™, Piccotex  
12          100™ or Piccotex 120™.

13

14        42. A method as claimed as in any one of Claims 35 to  
15           41 wherein the low molecular weight resin has an  
16           Mn (number average molecular weight) such that it  
17           has less than 500 repeating units.

18

19        43. A method as claimed in Claim 42 wherein the low  
20           molecular weight resin has an Mn (number average  
21           molecular weight) such that it has less than 50  
22           repeating units.

23

24        44. A method as claimed in any one of Claims 35 to 43  
25           comprising the additional step of adding one or  
26           more additives selected from the group consisting  
27           of UV inhibitors, antioxidants, flow modifiers,  
28           fire retarding agents, colour pigments and  
29           brighteners and oxygen scavengers as known in the  
30           art.

31

32        45. A method as claimed in any one of Claims 35 to 44  
33           where the glass transition temperature (T<sub>g</sub>) of the  
34           material is elevated as the polystyrene is mixed

1       with one or more low molecular weight hydrocarbon  
2       resins.

3

4       46. A method as claimed in Claim 45 wherein the T<sub>g</sub> is  
5       elevated to 5 to 10°C higher than the base  
6       polymer.

7

8       47. A container manufactured from a material that  
9       shatters when broken into fragments which do not  
10      cut, puncture or otherwise damage human skin or  
11      tissue.

12

13      48. A container as claimed in Claim 47 which is a  
14      bottle.

15

16      49. A container as claimed in Claim 47 which is a  
17      glass.

18

19      50. A container as claimed in Claim 47 which is a  
20      tumbler.

21

22      51. A container as claimed in any one of Claims 47 to  
23       50 wherein the material is a mixture of an  
24       amorphous thermoplastic polymer and one or more  
25       low molecular weight resins.

26

27      52. A container as claimed in Claim 51 wherein the  
28       amorphous thermoplastic polymer is chosen from the  
29       group consisting of: polystyrene (PS), styrene-  
30       acrylonitrile co-polymer (SAN), linear polyesters  
31       and co-polyesters polycarbonate (PC).

32

- 1       53. A container as claimed in Claim 51 wherein the one  
2           or more low molecular weight resins are  
3           hydrocarbon resins.
- 4
- 5       54. A container as claimed in A container as claimed  
6           in Claim 53 wherein the one or more low molecular  
7           weight resins are aromatic hydrocarbon resins
- 8
- 9       55. A container as claimed in Claims 53 to 54 wherein  
10          the one or more low molecular weight hydrocarbon  
11          resins are selected from a group consisting of:  
12           Norsolene™, Krystalex™, Plastolyn™, Endex™,  
13           Piccotex™, Piccolastic™, Sukorez™, Arkon™
- 14
- 15      56. A container as claimed in Claim 55 wherein the one  
16          or more low molecular weight hydrocarbon resins  
17          are selected from a group consisting of: Norsolene  
18           W90™, Norsolene W100™, Norsolene W110™, Kristalex  
19           F85™, Kristalex F100™, Kristalex F115™,  
20           Plastolyn 240™, Plastolyn 290™, Endex 155™,  
21           Piccolastic D125™, Sukorez 100™, Sukorez 120™,  
22           Arkon P100™, Arkon P125™, Arkon P140™, Piccotex  
23           75™, Piccotex 100™ or Piccotex 120™.
- 24
- 25      57. A container as claimed in any one of Claims 51 to  
26          56 wherein the low molecular weight resin will  
27          have a  $\bar{M}_n$  (number average molecular weight) such  
28          that it has less than 500 repeating units.
- 29
- 30      58. A container as claimed in any one of Claims 51 to  
31          56 wherein the low molecular weight resin will  
32          have a  $\bar{M}_n$  (number average molecular weight) such  
33          that it has less than 50 repeating units.

- 1
- 2       59. A container as claimed in any one of Claims 47 to  
3           58 wherein the material has a tensile stress limit  
4           between 11 and 60 Nmm<sup>-2</sup>.
- 5
- 6       60. A container as claimed in any one of Claims 47 to  
7           59 manufactured using injection blow moulding  
8           and/or injection stretch blow moulding  
9           techniques.
- 10
- 11      61. A container as claimed in any one of Claims 47 to  
12           59 manufactured using extrusion blow moulding.
- 13
- 14      62. A container as claimed in any one of Claims 47 to  
15           61 wherein the material contains an oxygen  
16           barrier.
- 17
- 18      63. A container as claimed in Claim 62 wherein the  
19           barrier included in the material is selected from  
20           the group consisting of: acrylonitrile-methyl  
21           acrylate copolymer, ethylene vinyl alcohol (EVOH)  
22           or nylon MXD6.
- 23
- 24      64. A container as claimed in Claim 62 wherein the  
25           barrier is Barex™.
- 26
- 27      65. A container as claimed in Claim 64 wherein the  
28           barrier is Barex™ 210 or Barex™ 218.
- 29
- 30      66. A container as claimed in any one of Claims 62 to  
31           65 wherein the barrier is overmoulded or sprayed  
32           onto the container.
- 33

- 1       67. A container as claimed in any one of Claims 62 to  
2               65 wherein the barrier is mixed with the material  
3               of the container, using co-injection techniques.  
4
- 5       68. A container as claimed in any one of Claims 47 to  
6               67 wherein the material contains one or more  
7               oxygen scavengers.  
8
- 9       69. A container as claimed in Claim 68 wherein the  
10               oxygen scavenger is selected from a group  
11               consisting of X-312, Amosorb 3000, or a scavenger  
12               of MXD6 with metal catalysed oxygen reduction  
13               chemistry.  
14
- 15      70. A container as claimed in any one of Claims 47 to  
16               69 having an inorganic coating.  
17
- 18      71. A container as claimed in Claim 70 wherein the  
19               inorganic layer is a thin layer of amorphous  
20               carbon.  
21
- 22      72. A container as claimed in Claims 70 to 71 wherein  
23               the inorganic coating is applied to the inside  
24               surface of the container.  
25
- 26      73. A container as claimed in any one of Claims 70 to  
27               72 wherein the inorganic coating will be applied  
28               in a layer of 100 to 200nm thickness.  
29
- 30      74. A container as claimed in any one of Claims 47 to  
31               73 having an external organic coating.  
32

- 1        75. A container as claimed in Claim 74 wherein the
- 2                external organic coating is PVDC or a two
- 3                component epoxyamine.
- 4
- 5        76. A container as claimed in any one of Claims 47 to
- 6                75 manufactured from multiple layers of the
- 7                material.
- 8
- 9        77. A container as claimed in any one of Claims 47 to
- 10                76 wherein the material includes one or additives
- 11                selected from the group consisting of UV
- 12                inhibitors, antioxidants, flow modifiers, colour
- 13                pigments and brighteners as known in the art.
- 14
- 15        78. A container as claimed in any one of Claims 51 to
- 16                77 wherein the glass transition temperature is
- 17                elevated as the amorphous thermoplastic polymer is
- 18                mixed with the one or more low molecular weight
- 19                hydrocarbons.
- 20
- 21        79. A container as claimed in any one of Claims 51 to
- 22                78 wherein the material has a glass transition
- 23                temperature of above 80°C.